APPARATUS AND METHOD FOR PROVIDING SEPARATE FORWARD DEDICATED AND SHARED CONTROL CHANNELS IN A COMMUNICATIONS SYSTEM

RELATED APPLICATIONS

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This application claims the benefit of U.S. Provisional Application No. 60/197,588, filed April 17, 2000.

BACKGROUND OF THE INVENTION

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The present invention relates to an apparatus and method for providing separate dedicated and shared control channels in a communications system and, more particularly, in a forward link of a Code Division Multiple Access (CDMA) communication system.

Typically in communication systems such as CDMA and, more

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particularly, CDMA evolutions such as WCDMA, dedicated channels are required for sending data and also for control of the system. Within the forward link of such systems, a single channel is used to carry the information to be transmitted and characteristics of the transmitted information are conveyed on another separate forward control channel. Each of these channels occupies a Walsh code

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from a finite set of available Walsh codes. To keep the system from becoming Walsh code limited it is important to conserve Walsh code resources. The allocation of these dedicated channels for each user typically requires rapid shuffling between dormant and active states to free up Walsh code resources. Problems that arise from this rapid shuffling include too few bits available, too

few users, too much power, too much reverse link automatic repeat request (ARQ), latancy, or too much reliance on using a data channel such as a shared channel (SHCH) for layer 3 information (e.g., switching of mobile stations between active and hold states) and ARQ. The shared channel SHCH is the forward channel used to send data packets to users in the active state and can reach very high peak data rates by using over 80% of the available Walsh code resources. However, the Walsh code resources are limited in the conventional systems because of the relatively small spreading factor sizes required to support the required payload and coding bits sent on the SHCH. Thus, a larger size spreading factor is critical for affording less power and more users to be supported, which are possible if bits can be more efficiently allocated.

Stated differently, the desire is to use as little of the Walsh Code resource as possible for a dedicated channel that, therefore, requires using a large spreading factor (a Walsh code of relatively large size such as 256 for CDMA2000 or WCDMA). The smaller the Walsh code resource used, the larger the number of dedicated channels that may be supported, which helps make rapid shuffling requirements less stringent. With a large spreading factor it is difficult to support many bits for a given frame duration, which is typically small (e.g. 3.33ms) to match that of a data channel like the SHCH, and to optimize over the air transmission and scheduling. Using smaller spreading factors not only uses more Walsh code resources, but requires more transmit power for a given reliability level and reduces system capacity. Also it is possible to achieve more bits with a

large spreading factor by using higher order modulation such as 8PSK but, again, at the expense of more transmit power.

There is therefore a need for a method and apparatus that affords more efficient allocation of bits and Walsh codes resources in a spread spectrum communication system.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a diagram of a communication system incorporating the method and apparatus incorporating a method and apparatus using separate dedicated and shared control channels in accordance with a preferred embodiment;

Figure 2 illustrates a frame format for a dedicated pointer channel in an assignment format according to a preferred embodiment of the present invention;

Figure 3 illustrates a frame format for a dedicated pointer channel in a null format according to a preferred embodiment of the present invention;

Figure 4 illustrates a frame format of a shared control channel according to an embodiment of the present invention; and

Figure 5 illustrates a schematic diagram for providing separate dedicated and shared control channels according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In order to better use the Walsh Code resource efficiently, it is possible to separate control and layer 3 information into data that is required to be sent in

every frame interval whether or not a mobile user is scheduled to receive data

over a data channel such as the shared channel (SHCH) and additional data that

only needs to be sent when the SHCH is scheduled for that user or when layer 3

information needs to be sent. Hence, it is more efficient to provide a set of

5   dedicated control channels for the data that is always required to be sent and a

smaller set of shared control channels for the additional data, which is sent less

frequently.

According to this scheme of separating information into different

channels, the dedicated control channel is always transmitted to a given user that

10   is not in a dormant state. The shared dedicated channel is allocated to a given user

if it is to receive data over a data channel such as the SHCH and needs

information to properly decode and use it or layer 3 information needs to be sent

and hence, in either case, more bits are needed. Typically, only a small number of

users (e.g., <3) will be simultaneously scheduled for a given frame interval or will

15   need layer 3 information, hence, a smaller number of shared control channels are

required compared to the dedicated control channels. Dedicated control channels

will be referred to as dedicated pointer channels (DPTRCH) in this description.

Hence, the present invention is directed to a method and apparatus that

provide a separate pointer channel and shared control channel instead of a single

20   control channel as employed in the conventional systems. Thus, a statistical

approach can be taken that allows control information and other information that

is requisitely persistent to be transmitted via a dedicated control channel while

other information that is intermittent may be transmitted in shared channel

resources. This statistical splitting of control information into multiple channels affords more economical use of Walsh code resources and sufficient bits at lower power levels without over reliance on the shared channel SHCH. The dedicated pointer control channel DPTRCH is used to continuously communicate

5   information including whether or not a mobile unit in a forward link portion of a spread spectrum communication system has need to receive information concerning a data channel such as a shared channel SHCH that is accessed via the shared control channel SHCCH. Hence, the dedicated pointer control channel DPTRCH is used to point to the shared control channel SHCCH when information

10   is to be sent via a data channel, in this case the shared channel SHCH, thereby allowing the shared channel resources to be used only when needed and, hence, more efficiently.

Figure 1 illustrates a communication system, shown generally at 10, including a base station 12 and a mobile unit 14. Within the forward link from the

15   base 12 to the mobile 14, is the shared channel SHCH, the shared control channel SHCCH and the dedicated pointer control channel DPTRCH as identified in Figure 1. In the present system, however, only the dedicated power control channel DPTRCH is persistent, allowing only those mobile units in an active state that require further control via the shared control channel SHCCH and the forward

20   link channel SHCH to have more available Walsh codes to use. The dedicated pointer control channel DPTRCH is used to point to a pool of shared control channels SHCCH that supplement the payload of the dedicated pointer control

channel DPTRCH in order to convey assignments on the shared data channel SHCH.

Figure 2 illustrates a typical dedicated pointer control channel frame 20 in an assignment format (i.e., when the frame is used to convey information concerning a shared control channel SHCCH). Within this frame 20 are a number of information fields that are used to convey information essential for maintaining users in the cell area of the base 12, whether in inactive or control hold state. The first field is an indicator or pointer field 22 that communicates whether information on a shared control channel SHCCH needs to be transmitted and the Walsh code assignment of the particular shared control channel SHCCH to which this field points. The pointer field 22 may be of any length necessary to communicate the number of different shared channel Walsh codes allocated for the shared channels. In a preferred embodiment, this pointer field is set at 3 bits, which is capable of communicating up to 8 different states of the shared channel SHCCH.

The next field within the dedicated pointer channel DPTRCH frame 20 is a reserved link control 24 that is used to communicate information such as the message sequence length shown in field 30 contained within the reserved link control field 24. The reserved link control field 24 may also contain reverse link scheduling information (not shown). Further information may include a hybrid automatic repeat request HARQ shown in field 32 of the reserve link control 24. In an alternate embodiment, the reserved link control field 24 may contain the starting Walsh code, the modulation coding scheme (MCS) and ARQ information.

The dedicated pointer channel frame DPTRCH also contains cyclic
redundancy check CRC information for forward error correction shown in field 26
of the frame 20. Additionally, the frame contains power control bit information
27 to regulate the reverse link power for a CDMA system and a tail 28 to mark the
5   end of the frame.

According to a preferred embodiment, the dedicated pointer frame
DPTRCH is typically 5 milliseconds long. However, the time length of the frame
is not limited to this amount, but could be modified to whatever particular
communication system the frame is being used. Similarly, the fields and width in
10   bits may also be modified on the DPTRCH.

Figure 3 illustrates a dedicated pointer channel frame DPTRCH in a "null"
format or, in other words, when information is not required to be transmitted on a
corresponding shared control channel SHCCH. Similar to the assignment format
20, the null frame 34 contains a pointer field 35, a CRC field 37, a power control
15   bit field 38 and a tail 39. Different from the assignment format, the null frame
format merely transmits a reserved field 36 containing reverse link scheduling
information for the reverse link in a CDMA system.

Figure 4 illustrates a shared control channel SHCCH frame shown
generally at 40. This frame includes an assignment field 42 having various
20   aperiodic or intermittent information such as information required for
demodulation of the shared channel SHCH or as a transport for automatic repeat
request ARQ feedback in layer 3 signaling information. The assignment field 42
of Figure 4 is shown to include fields 48-50, which may include a field 48 for

indicating the particular modulating coding scheme MCS that is used in the .

forward shared channel SHCH, a starting Walsh code 49 and gain information 50.

Similar to the dedicated pointer control frame, the shared channel frame 40 also

includes a cyclic redundancy check CRC field 44 and tail information in field 46.

5   Correlating with the alternate embodiment discussed previously in connection

with Figure 2, the assignment field 42 may instead contain gain information, ARQ

information and Layer 3 signaling information, while the dedicated pointer

channel frame carries information concerning the starting Walsh codes, the MCS

and further ARQ information. Other combinations of field assignments to the

10   DPTRCH and the SHCCH are also possible.   In addition, further enhancements

of the scheme are readily observable, such as additional levels of SHCCH and

joint coding (either correction or error detection) across the codes a user receives

and uses.

Within the present system, to insure that sufficient number of Walsh codes

15   are available for the forward shared channels, the dedicated pointer channel

DPTRCH and shared channel SHCCH are assigned to part of a Walsh code tree

that does not overlap with the codes for the forward shared channel SHCH. For

example, for Walsh codes of length 16, the dedicated pointer channel DPTRCH

and shared control channel SHCCH would be assigned to a portion of a Walsh

20   code tree that does not overlap with codes 2-15 of length 16, for instance. In a

preferred embodiment, mobile users in the active state maintain a unique

dedicated pointer channel DPTRCH that is assigned a Walsh code of length 512.

Figure 5 illustrates an apparatus for generating the respective dedicated

pointer control channel DPTRCH and shared control channels SHCCH. A

dedicated pointer control channel generator 60 includes a convolutional coder 64

that receives control data from a transmitter (e.g., a base station) be input thereto.

5   The convolutional coder 64 encodes the data at a particular coding rate (e.g., R =

½ rate sets). The encoding data is then sent to an interleaver 66 that interleaves

the data according to any numberof known interleaving schemes. After the data is

interleaved, an M-ary modulator 68 modulates the data according to any number

of known modulation schemes such as QPSK or 8PSK. The modulated data is

10   then sent to multiplexer 70, which multiplexes the modulated data with power

control bit information. The power control bit is included in the dedicated pointer

DPTRCH since this information is required for each user within the base station

12 cell, irrespective of whether the mobile is in the active or control hold state (an

active state being when data is transmitted to be received by the mobile and the

15   control hold state being when no data is transmitted to the mobile). The

multiplexed data B_{DPTR} output from the multiplexer 70 is then multiplied by a

multiplier 72 with a Walsh code w_n and output for transmission at particular chip

rate R_c. Preferably, the chip rate is equal to 1.2288 million chips per second

(Mcps) according to the IS95 standard or 3.84 Mcps according to WCDMA.

20   Additionally, a switching element (not shown) or some other equivalent

means to prevent the control data B from being transmitted may be utilized as will

be appreciated by one of ordinary skill in the art. The control data B is prevented

from being transmitted in those instances where a mobile is in a control hold state

and no data via the shared channel SHCH is to be transmitted to the mobile 14

within the time frame of the dedicated pointer channel frame. Hence, a "null"

frame will be generated with only the requisite power control bit information.

5   A shared control generator 62 contains similar elements as the dedicated

pointer channel generator 60, including a convolutional encoder 74 and interleaver

76 and an M-ary modulator 78. However, the shared channel control generator 62

does not require a multiplexer since the power control bit information is sent only

via the dedicated pointer control channel DPTRCH. Thus the modulated control

data B_{SCH} from the modulator 78 is multiplied by multiplier 80 by Walsh codes w_n

10 for transmission on the forward link. Of course, if a mobile unit to which control

data is sent is in the control hold state no control data B_{SCH} will be transmitted via

the shared controlled channel generator 62.

As stated previously, utilization of a dedicated pointer channel DPTRCH

transmitting only essential persistent control information and pointing to

15 intermittent control information carried on the shared control channel SHCCH

only when the intermittent control information has needs to be sent affords more

efficient allocation of system resources in a spread spectrum communication

system. Additionally, it will be appreciated by those skilled in the art that the

present method and apparatus may be utilized in other communication systems

20 that transmit overhead information such as control information in order to

efficiently allocate resources.

The present invention has been described for exemplary purposes in terms

of presently preferred embodiments. It should be understood, however, that

persons of ordinary skill in the art may otherwise embody its broad teachings

without departing from its fair scope.